

Remarks

Claims 1-12 are pending herein. Claims 1-6 have been withdrawn as being directed to a non-elected invention. By this Amendment, claim 7 has been amended to recite in the first step thereof: forming the silicon nitride film on the workpiece by reacting the hexachlorodisilane and the ammonia in the reaction vessel. Support for the recitation “by reacting the hexachlorodisilane and the ammonia in the reaction vessel” is found, e.g., in the preamble to claim 7 itself. Because the added recitation is based on language already present in claim 7, Applicants respectfully submit that the amendment to claim 7 does not raise new issues.

In the Office Action, claims 7, 8, 11 and 12 are rejected under 35 U.S.C. §103(a) as being unpatentable over R.C. Taylor et al. “LPCVD of Silicon Nitride Films from Hexachlorodisilane and Ammonia” (“Taylor”) in view of U.S. Patent 6,486,083 to Mizuno et al. (“Mizuno”) and Applicant admitted prior art (“Admitted Prior Art”); and claims 9 and 10 are rejected under §103(a) as being unpatentable over Taylor, Mizuno and Admitted Prior Art as applied to claims 7, 8, 11 and 12 and further in view of U.S. Patent 6,159,298 to Saito et al. (“Saito”).

In view of the amendments and remarks herein, Applicants respectfully request reconsideration and withdrawal of the rejections set forth in the Office Action.

I . Rejection of Claims 7, 8, 11 and 12

In the §103(a) rejection of claims 7, 8, 11 and 12, Taylor is cited for teaching supplying hexachlorodisilane and ammonia to a reaction vessel to form a silicon nitride film on a workpiece. However, Taylor does not teach discharging ammonia from the reaction vessel into the exhaust pipe to pre-clean the inside of the exhaust pipe. Mizuno is cited for teaching that an exhaust pipe is necessarily present in the Taylor process and for teaching discharging ammonia from the reaction vessel into the exhaust pipe after depositing the silicon nitride. Taylor does not teach that a Si-Cl-N-H compound remains in the exhaust pipe. The Admitted Prior Art is cited for teaching that the reaction of hexachlorodisilane and ammonia forms a Si-Cl-N-H compound as an intermediate product. Therefore, according to the Office Action, it would have been obvious to modify Taylor by including the step of discharging ammonia from the reaction vessel into the exhaust pipe as taught in Mizuno and to recognize that the Si-Cl-N-H compound is formed in Taylor as taught in the Admitted Prior Art. The Office Action states that such modification is proper because Taylor discloses increasing the ammonia flow rate and, citing Mizuno at col. 2, lines 28-29, further because such modification “would provide a silicon nitride film having better uniformity and a process having less contamination on the final product.”

Applicants respectfully submit that, for at least the reasons given below, Mizuno does not provide any motivation to modify the Taylor process so as to supply ammonia into the reaction vessel after completion of forming the silicon nitride film and then discharging ammonia from the reaction vessel into the exhaust pipe.

Claim 7 has been amended to recite the step of forming the silicon nitride film on the workpiece by reacting ammonia and hexachlorodisilane. The reaction of ammonia and hexachlorodisilane produces a Si-Cl-N-H compound as an intermediate product. In the method set forth in claim 7, the ammonia discharged from the reaction vessel into the exhaust pipe reacts with the Si-Cl-N-H compound remaining in the exhaust pipe to produce a Si-N-H compound which precleans the inside of the exhaust pipe.

The Taylor process also uses ammonia and hexachlorodisilane to make silicon nitride. However, Mizuno does not use hexachlorodisilane. Instead, Mizuno uses ammonia and bis tertiary butyl amino silane ("BTBAS"). Hexachlorodisilane and BTBAS are different compounds which react with ammonia to produce different byproducts.

Mizuno does not teach or suggest that the discharge of ammonia from the reaction vessel into the exhaust pipe is advantageous regardless of what other starting material is reacted with the ammonia. Mizuno's teachings are specifically based on the use of BTBAS as a starting material. For example, Mizuno defines the problem to be solved therein as follows:

[t]he present inventors, however, have found that when a silicon nitride film or a silicon oxynitride film is formed using **BTBAS, uniformity in thickness of the formed film over the entire surface of the substrate is not sufficient** [emphasis added]. [See col. 1, lines 46-49]

Mizuno describes the invention therein as follows:

[a]ccording to the present invention, when a silicon nitride film is formed using **BTBAS and NH₃** as raw gases, or when a silicon oxynitride film is formed using BTBAS, NH₃

and N₂O as raw gases, **uniformity in thickness of the formed film over the entire surface of the substrate wafer can be enhanced** [emphasis added]. See col. 7, lines 40-45.

Thus, Mizuno is directed to providing silicon nitride and silicon oxynitride films having improved uniformity in thickness when BTBAS is used as a starting material. The reference does not suggest the use of a different starting material but rather is directed to improving silicon nitride and silicon oxynitride films made specifically from BTBAS. Therefore, Mizuno's teachings regarding ammonia relate only to when BTBAS is used as a starting material, not when a different starting material, e.g., hexachlorodisilane, is used. Mizuno teaches nothing regarding the uniformity in thickness of silicon nitride films formed when hexachlorodisilane or some other starting material is reacted with ammonia. Thus, Mizuno provides no motivation to modify the Taylor process.

In instant claim 7, the ammonia discharged from the reaction vessel into the exhaust pipe reacts with the Si-Cl-N-H compound remaining in the exhaust pipe to form a Si-N-H compound, which precleans the inside of the exhaust pipe. The Si-Cl-N-H compound is a by-product of the reaction between ammonia and hexachlorodisilane. Because Mizuno does not teach the reaction of ammonia and hexachlorodisilane, the reference does not teach or suggest reacting ammonia with any of the byproducts of such reaction. Mizuno does not even teach what byproducts result from the reaction between ammonia and BTBAS. Thus, Mizuno provides no motivation to react ammonia with any byproducts formed in the Taylor process, particularly after formation of the silicon nitride film is completed.

Therefore, for at least the foregoing reasons, Applicants respectfully submit that claims 7, 8, 11 and 12 are patentable over Taylor in view of Mizuno and the Admitted Prior Art.

II. Rejection of Claims 9 and 10

Claims 9 and 10 are rejected under §103(a) as being unpatentable over Taylor, Mizuno and Admitted Prior Art as applied to claims 7, 8, 11 and 12 and further in view of Saito. According to the Office Action, the combination of Taylor and Mizuno does not specifically show heating the exhaust pipe at 100°C or above and setting the pressure in the range of 665 to 66500 Pa. Saito is cited for teaching heating the exhaust pipe at 150°C and using a pressure of 5 torr (665 Pa).

Claims 9 and 10 depend upon claim 7. Applicants submit, therefore, that for the reasons given above, claims 9 and 10 are patentable over Taylor, Mizuno and Admitted Prior Art, i.e., the references (particularly Mizuno) do not provide motivation to modify the Taylor process so as to discharge ammonia from the reaction vessel into the exhaust pipe and react the ammonia with a Si-Cl-N-H compound remaining in the exhaust pipe. Saito also does not provide this motivation since it does not teach the use of hexachlorodisilane as a starting material and does not teach the step of discharging ammonia from the reaction vessel into the exhaust pipe after formation of the silicon nitride film is complete.

Therefore, for at least the foregoing reasons, Applicants respectfully submit that claims 9 and 10 are patentable over Taylor in view of Mizuno, the Admitted Prior Art and Saito.


III. Conclusion

In view of the amendments and remarks herein, Applicants respectfully request that the rejections set forth in the Office Action be withdrawn and that claims 7-12 be allowed.

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